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Physiology
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A N
INAUGURAL DISSERTATION
ON THE
PRINCIPLE OF ANIMATION:
— SUBMITTED TO THE —
EXAMINATION
OF THE
REV. JOHN EWING, S. T. P. PROVOST;
THE
TRUSTEES & MEDICAL FACULTY,
OF THE
UNIVERSITY OF PENNSYLVANIA,
On the twenty-seventh of May, 1802,
FOR THE DEGREE OF
DOCTOR OF MEDICINE:

— ♦ —
BY JOSEPH MACRERY, ✓
OF DELAWARE.

— ♦ —
Principio cælum, ac terras, camposque liquentes,
Ludentemque globum lunæ, titiniaque astra,
Spiritus intus alit, totamque infusa per artus
Mens agitat molem, et magno se corpore miscet.

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VIRG. ÆN. vi.

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W I L M I N G T O N :

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— ♦ —  
1802.



T O  
 JAMES TILTON, M. D.  
 PRESIDENT OF THE  
*MEDICAL SOCIETY OF DELAWARE,*  
 THIS ESSAY IS  
 DEDICATED,  
 AS A MARK OF  
 RESPECT AND GRATITUDE,  
 FOR THE MANY FAVOURS  
 CONFERRED ON HIS  
 SINCERE FRIEND AND AFFECTIONATE PUPIL,  
 JOSEPH MACRERY.







ON THE  
PRINCIPLE OF ANIMATION.

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THE principle of animation has been known by a great variety of names. We have the                      of Hippocrates ; the of the Platonists and Stoics ; the anima vegetans of the writers of the middle age ; the archeus of Van Helmont and Stahl ; the æther of Newton ; “ the Form,” of Harris ; the vis vitæ of Haller ; the materia vitæ diffusa of Hunter ; the nisus formativus of Blumenbach ; and the fire or electricity of Hutchinson and Valli.

There appears to be two principles during life, which are continually opposed to each other. First the principle of animation, which by the energy of its unifying power, is continually separating common matter from its elementary state, harmonizing it with itself, and organizing it into systems : and another principle which we call nature, which through the medium of the chemical, or different affinities, of different modifications of matter, is perpetu-

ally tending to reduce them to a common state. The usual process for this end, is fermentation, putrefaction and gravitation; which process begins in organized systems, as soon as life ends. Nature is the efficient cause, by the energy of which the symmetry of the material world is preserved—is the bond of union between the different parts of common, as the principle of animation is between different parts of living matter. As soon then as the matter of living systems loses this participation of life, it becomes amenable to the general law of physics, and the system is resolved into its constituent parts.

In considering the principle of animation, I shall not only view it as it exists in man, but as it exists throughout the whole of the animal and vegetable kingdom. Simple life appears in its most perfect state, in those animated organized systems, which possess the preservative, assimilative, reproductive and procreative powers, in the highest degree. From the earliest ages, life has been supposed by all men, to depend on a certain vivifying principle, by the energy of which, matter is deprived of its sensible qualities; is reduced from a heterogeneous to a homogeneous state, and is converted into organized animated systems.

These systems, while they retain the principle of animation, possess the power of acting on matter, and preserve themselves by resisting its different affinities ; but as soon as this vivifying principle departs, death takes place ; then matter instead of being acted on *by* the system, acts *on* the system, and by means of the different affinities, fermentation and dissolution follow.

Before we enter into the consideration of what this vivifying principle is, it will be necessary in the first place, to take some notice of an hypothesis that has lately been promulgated, which proclaims life to be a forced state ; an effect merely of causes which are dead !—for if this be true, a vivifying principle is out of the question, and our labor is at an end.

Doctor Brown, an eccentric genius of the last century, was the author of this hypothesis. He asserts that the action of stimuli on the excitability of the system produces excitement, which is life. Excitability he defines to be a something residing in the nervous, and muscular fibres, which has the capacity to be acted on by stimuli ; but he is unable to determine whether it is a quality or a sub-

stance ; and further maintains, that a certain determinate portion is allotted to every living system. If this were really the case, mankind would pass on from their birth, to their death, in a continued course of wakefulness. In order to get clear of this, and other facts, that militate against the above hypothesis, he asserts that there is a continual production, exhaustion and accumulation of this principle during life. Thus he is forced to contradict himself in the most fundamental axioms of his theory.—Stimuli he defines to be certain substances that have the power of acting on the principle of excitability, which, he says, is not life, for “life is the sole effect of stimuli?”—From a view then of this doctrine it would appear, that the excitability decreases in proportion to the increase of excitement, and vice versa. Of course, in infancy and youth, where there is much excitement there should be little excitability ; and in old age, when there is but little excitement, there would be a total accumulation of excitability. If this were the real state of things, instead of having “ a continual tendency to death,” we would have a continual tendency to life ; from the increase of excitability in the ratio with the decrease of excitement, and life might be perpetuated ad infinitum by the proper application of stimuli.

Thus we would be forced to live instead of being "forced to die." Brown's notion of vital action must have been strangely confused. In the first place, he defines excitability to be a capacity in the organized system, to produce motion, or excitement on the application of stimuli. This is life. We have many familiar examples of this mode of action. A steel spring has the capacity to be acted on, to produce motion; a stone has the capacity to be acted on; a top has the capacity to be acted on; all move when the stimulus is applied, but no life is produced. Capacity implies passiveness, and is therefore much more applicable to dead, or common, than to living matter. Yet it is obvious, that he grounded his system on the action he saw common matter display. The animated, organized system, retains its vitality, not by its capacity to be acted on, by stimuli, but by their capacity to be acted on, by its vital assimilative powers. As soon as death takes place, this order is inverted, the system then possesses the capacity to be acted on by air, heat, and the other stimuli; the product is not life; but putrefaction, fermentation and the resolution of the system into its constituent parts. Indeed, Dr. Brown appears to have begun where he should have ended. He

makes life the effect of the action of matter on inanimate organized systems ; when it is well known, that the action of matter on such systems, invariably produces disorganization, and decomposition. Instead of making action the effect of life, he makes life the effect of action ; “for in action (excitement),” says he “the true cause of life consists, the effect of the exciting powers acting on the excitability.” Life therefore does not consist in the excitability alone, or in the exciting power alone, but in both together. Further, he and his followers assert action to be the *sine qua non* of life. But life may, and does exist, without action ; as in asphixia, and in hybernating animals. The seta equina, wheel polypus, and many others may be dried in the sun for years ; or baked in an oven, till they are like dried gluten, without hurting their vital principle ; and may be revived at any length of time, by moistening them with water. The seeds of many vegetables, retain their vital power for centuries. Action is an effect of organization ; but organization is an effect of the principle of life ; organization therefore is the final, and not the efficient cause of life.

The Dr. maintains, that the whole phenomena of life, depend on the operation of sti-



multi—on a certain arrangement of matter, constituting the principle of excitability : but he never enquired how this arrangement was formed, and by what power it was produced. He must have supposed that bodies are formed in a manner somewhat similiar to the chrysalization of salts ; and then life created by the action of matter on organized systems, which were before inanimate. This is indeed, a “ forced state,” as he calls it. Organization is generally supposed to be an effect of life. But here we see life an effect of organization, and posterior to it ; or in other words, the *effect* preceding the *cause*. This doctrine favours not a little of Atheism ; as it proclaims the creation, and existence of an effect without a cause ; for if life is neither in the excitability, nor in the stimuli, but is produced by their action on each other, it should be a *tertium quid*, or neutral compound. But that life is any thing like a compound of these agents, none of his supporters will pretend to assert.

Philosophers and physiologists have generally agreed in placing the vital principle in the brain and nerves ; constituting the principle of sensibility ; or in the muscles, forming the principle of irritability. If we take but a slight view of the vital principle, as it is found

through the whole of animated existence, we will find at once, that irritability must be the principle of animation ; for a great part of the animal, and the whole of the vegetable kingdom, have neither brain nor nerves ; yet they have all irritability, although not all muscular fibre, for irritability may, and does exist without it. Even in man, and some of the higher orders of animals, where these two principles are very intimately interwoven, they may, and do exist independently of each other for some length of time ; as in fœtus' born alive without heads ; and when, what is commonly called death has taken place, the sensibility has merely left the body, the vital or irritable principle still exists. In this state the lymphatics continue to absorb. A muscle cut from the body, trembles and palpitates. The heart contracts for some length of time after it is separated from the system, and the intestines, when torn from the body, and placed on a table, continue to roll and move on each other, until they become stiff and cold. It is owing to the remains of life in the muscles, that the body maintains whatever situation it is placed in at death, until the organization fails, and decomposition begins to take place. This decomposition occurs sooner or later, in propor-



tion as the irritable or vital principle has been expended before death. In some cases it begins immediately. Oxen over-driven before they are slaughtered, and the bodies of persons killed by electricity or poison, soon become putrid. This vital principle exists in some affections of the body, independent of the sentient, even while what is called life continues ; as in palsy. It survives its separation from the brain, as in frogs and turtles, which live weeks and months without their heads ; and even its connection with the rest of the system, as in animals that continue to live after being cut into a number of pieces, as in polipi and sea anemones. Those functions called vital, as the circulation by which the system lives, depend entirely on the irritable principle, and continue an unwearied course of action through life. Whereas a state of rest is indispensibly necessary, to those which depend on the nerves and volition. The mind and nervous system, so far from being necessary to simple and perfect animal life, appear to be a real burden, and enemy to it ; simple animal life subsists much better without them : for whenever volition interferes, it deranges the animal functions, and tends to destroy the preservative principle. This appears to be the reason, why the vital functions are removed as

far as possible beyond the reach of volition ; but still this principle has such power in man, as frequently to destroy life, and always has the effect to weaken it. So that we generally find the living powers to be in the inverse ratio of the intellectual, which are often strongest in the most rickety, decrepid and deformed systems. Newton, Pope, and many other celebrated genius', might be adduced in proof of this assertion. Indeed, no kind of exercise appears to wear out the vital powers sooner than that of the mental faculties. The organs of the vital functions have such a small portion of nerves distributed to them, that their very existence was for a long time denied. These nerves appear to serve merely as a connecting medium with the system ; for the vital functions of the organs which they supply, are carried on best when the will is quiescent. After sensibility has become extinct, and what is commonly called death has taken place, as after suffocation, by operating on this vital irritable principle, we can restore the circulation, reanimate the nervous system, and recover that life which seemed entirely to have left the body. This, with many other facts, proves the irritable principle to be the prime mover and source of life. The heart when it appears as a punctum saliens in the midst of the gelatinous em-

orio, acts wholly by the energy of this principle, for at this time there is no appearance of either brain or nerves. The source then of all the actions of life is irritability ; its diminution debility ; its absence death. We will, next in order, consider what this principle is, and what it depends on. Some have asserted that it depends on the brain and nerves : but I hope we have already shown, that sensibility, and not irritability depends on the nerves. A later, and very generally received opinion is, that oxygene is the principle of irritability.

The necessity of oxygene in respiration, has been explained by Godwin, and several others. But Dr. Girtanner is the first who openly maintained oxygene to be irritability, the proximate cause of life ! As the Dr. is the founder of this hypothesis, and may be considered its principal supporter, I will just state a few of his leading principles, as nearly in his own words, and in as concise a manner as possible.

Axiom 1st. “ The irritability of organized bodies is always in a direct ratio of the quantity of oxygene they contain.”

This is by no means true, even in man, for

we find that the system is more highly irritable in the fœtal state, and shortly after, than at any other period of our existence ; the blood of the fœtus is of a darker colour than that of the adult, this is easily accounted for, when we consider that it receives its oxygene solely from the mother, by means of a tedious circulation, through the medium of the placenta, where the blood, as is evident from the black colour of the placenta, has already become venous. Even for some time after birth, although the system is highly irritable, the blood is but partially oxygenated ; owing to its imperfect transmission through the lungs. The foramer ovale sometimes continues open for a year, or more, without any apparent inconvenience. And with respect to the greater part of the animal, and the whole of the vegetable kingdom, oxygene so far from being the principle of irritability, or life, is thrown out from their whole surface as noxious and dead ; at the same time that they thrive, and grow in proportion to the quantity of azotic, and carbonic acid gas, in which they are enveloped.

Axiom 2d. "Every thing that increases the quantity of oxygene in organized bodies, increases at the same time their irritability."

To illustrate and substantiate this position, he adduces the phenomena attending on the action of the mercurial salts, and oxydes upon animals, the symptoms of which are the same as in the scurvy; which he asserts is a disease of super-oxygenation. But all the phenomena of scurvy, as well as its cure, prove it to be a disease of de-oxygenation. And oxygene when accumulated in organized inanimate systems, instead of rendering them irritable produces fermentation and decomposition.

His theory of vital action is as follows.—  
 “All substances which come in contact, with the living fibre, may be comprehended under three classes.”

1st. “Substances which have the same affinity to oxygene with the irritable fibre, are inert:”

2d. “Substances which have a less affinity to oxygene than the fibre has, surcharge it with oxygene, and produce the state of accumulation: these may be called negative stimuli.”

3d. “Substances which have a greater affini-

ty to oxygene than the fibre has, deprive it of oxygene, and produce the state of exhaustion : these may be called positive stimuli." According to axiom 2d, then, negative stimuli oxygenate the fibre, and destroy life by not supporting action. I would ask, do cold and hunger, which are negative stimuli (for they operate in the way all other negative stimuli are supposed to do, by not supporting action) oxygenate the fibre ? And is it likely, that the salts, and calces of metals, as red precipitate, corrosive sublimate, lunar caustic, and white arsenic, which he supposes are negative stimuli, induce inflammation, and spiculus by oxyding the fibre ? Where then is the positive stimulus to produce the inflammation ? Or must we suppose the oxygene acts on itself ? As those seem to think who believe it to be not only the principle of irritability, but the agent that acts on it !! A negative stimulus, one would naturally suppose, when taken into the stomach, would cause an accumulation of irritability in the whole of that organ ; and the action of any stimulus would produce a general inflammation. But the fact is, that in death from arsenic, the inflammation is nearly limited to the spot in contact with the arsenic, which is generally gangrenous. And further, we know that the use of the oxygenated muri-



ate of Potash, several of the acids, and many other substances, that contain more oxygene, and part with it more readily, have none of these effects. Even the breathing of pure oxygenous gas, but gently increases the heat of the body, without inducing any kind of inflammation.—

The 3d axiom I believe to be equally false with the 2d. In it, he asserts, that all substances are stimulating in proportion to their greater, or lesser affinity for the oxygene of the irritable fibre; and that the action of the living fibre, is the effect of the combination of its oxygene with the stimulating substance. Here I would ask, is it likely, that pieces of broken glass, particles of sand, thorns or pins, all which stimulate when they come in contact with the irritable fibre, induce action, pain and inflammation, by combining with its oxygene, by a superior chemical affinity? Can any proof be given of their having suffered a chemical change? Does volition combine with the oxygene of the muscles of our limbs when we choose to walk? Is it probable, that the deadly poisons, from the animal or vegetable kingdom, which when applied in a very small quantity to any part of the body, destroy instantaneously the irritability of the whole system, thus

annihilate life, by combining with all the oxygene of the irritable fibres ? We have no evidence of such strange effects from the affinities, as Gertanner supposes here. And if it were even possible for us to see the operation going on, we would find it difficult to credit our senses. The ingenious professor Barton, has ascertained by experiment that camphor increases the life and irritability of plants. The effect was permanent. Many other substances which are not supposed to contain oxygene, act very powerfully in restoring and augmenting the irritability, of both plants and animals. Professor Humboldt has proved, by a great variety of ingenious and well conducted experiments, made on the hearts, and other irritable parts of animals, that oxygene is not the irritable principle ; for that the irritability of the fibre may be increased, and renewed by substances, which do not contain oxygene ; and even after the application of oxygene had ceased to produce any effect. Some of these substances are electricity, the alkalies, phosphorus, opium, and hydrogen. I have repeated several of his experiments myself, and have found precisely the the same results.—

Oxygene possesses the capacity to be acted on by the lungs, and assimilative powers of animals, as carbonic acid gas, and nitrogen



do by vegetables. Oxygene is to be considered in the same point of view then as any other nutrieious substance. Which substances are salutary, only so long as the principle of life has the power of acting on them. If the organs were dead, all the oxygene in the universe would be insuffieient to produée vitality in the human frame. Nay, if the ehemieal aetion, which it is supposed oxygene exerts on the system, to produée life, did really take place, death, disorganization, and deeomposition, would be the inevitable eonsequeene. To say that oxygene is the principle of life or irritability, because its presenee is neeessary to the animal economy, is a very unphilosophieal deduction. It might as well be said, that water, lime, iron, azote, and earbone, were the principles of life ; for their presence is equally neeessary in the animal body. Oxygene, when vitalized and assimilated to the blood, appears to constitute the means, by which it is fitted to be conveyed by the vascular system, to the different parts of the body. But this does not make it the principle of life. For water and caloric, are equally neeessary for this purpose. Some have supposed that it creates life, in so far as it aets as a stimulus. If this were true, it still would not constitute the principle of life,

for we would have fifty others, as alcohol, opium, azote, &c.

It may now be deemed incumbent on me to state, what I believe to be the efficient cause of life. I will take the liberty here to assert, that all the phenomena of life and motion, are owing to the energy of a subtile, active principle, called the electric fluid: which fills the immensity of space, actuates every particle of matter, and is the universal principle of animation and motion. Although this may be deemed an absurd hypothesis, both by the oxygenous philosopher, and the mechanical theorist of life, yet, by attending to the records of philosophy, we will find, that it has been held under one form or other by the greatest and wisest men in all ages.

Pythagoras admitted one primary active principle, which he called a subtile fire, or æther: this he asserts animates all things, and is the efficient cause of motion. Heraclitus maintained that fire, or the ætherial principle which pervades and animates the universe, has within itself eternal and necessary motion, by the energy of which, all the forms of nature are produced. Plato asserts, that the anima mundi, ( )

is the cause or principle of motion (

), this anima mundi he describes as a fiery principle, essentially active. Aristotle maintains that animal heat, (

) of which he expressly says all things are full, is the universal vital principle. Indeed, almost all the ancient philosophers held the existence of a subtile, ætherial, fiery principle, which is essentially active, pervades the universe, and is the efficient cause of animation, organization and motion. The Pythagoreans, Stoics, Platonists and Peripatetics, called this principle plastic nature. Many celebrated modern characters have assumed this principle, as Berkeley, Harris, Cudworth, Monro, Young, and many others. Newton ascribes the same properties to his æther, that the ancients did to their plastic nature. The late important discoveries in electricity, have shown this plastic nature, to be one and the same with the electric fluid.

The matter of galvanism, magnetism, electricity, heat and light, appear to be only modifications of one and the same elementary principle, which may be called the electric fluid. “*Entia non sunt multiplicanda absque necessitate.*” According to Boscovich, life, organization and motion, are the effects of attrac-

tion and repulsion. The electric fluid is now acknowledged to be the universal principle of attraction and repulsion, and of course of all the phenomena of nature.

Many arguments and facts might be adduced to prove the electric fluid to be the universal principle of animation and motion, did not the limits I have prescribed to this imperfect essay preclude them.

F I N I S.





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